VERY LARGE NUMBERS

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In modern times, mathematicians have thought about very large numbers, and have invented names for them. Articles on this subject appeared in the February and May 1968 issues of Word Ways.

There is a tendency for us moderns to assume that only we have assigned names to large numbers. This unconscious assumption seems to reflect our cultural descent from the civilizations of ancient Greece and Rome. The Greeks had no terminology for denominations above the MYRIAD, or ten to the fourth power, and the Romans had none beyond the MILLE, or ten to the third power.

The Greeks and Romans did not, of course, constitute the sum of ancient civilization. Antedating the Classic European civilizations were some on the continent of Asia, such as those of China and India. At a very early time in history, the civilization of India developed astonishingly extended numerical notations. Instead of thinking about the CENTILLION (ten to the 303rd power) or the GOOGOL (ten to the 100th power), they contemplated the TALLAKSANA (ten to the 53rd power) or the ASANKHYEYA (ten to the 140th power).

The purpose of this article is to exhibit four early systems of numeration, developed by Hindu mathematicians in the period between 1000 B.C. and A.D. 900. The names in these systems are set out in the four lists below; the values (in powers of ten) corresponding to these names are given at the left. The first list gives a decuple system from the Sâṅkhyâyana Srauta Sûtra (prior to the 5th century B.C.), and the second exhibits notational place names according to Mahâvîra (850 A.D.):

0 eka	4 ayuta	8 nyarbuda	12 antya
1 daśa	5 niyuta	9 nikharva	13 ananta
2 sata	6 prayuta	10 samudra	
3 sahasra	7 arbuda	11 salila	

0 eka	6 daśa-laksa	12 kharva	18 śaṅkha
1 daśa	7 koti	13 mahâkharva	19 mahâ-śaṅkha
2 śata	8 daśa-koti	14 padma	20 ksiti
3 sahasra	9 śata-koti	15 mahâ-padma	21 mahâ-ksiti
4 daśa-sahasra	10 arbuda	16 ksoni	22 ksobha
5 laksa	11 nyarbuda	17 mahâ-ksoni	23 mahâ-ksobha

Notice that most powers of ten have a separate name. Western

nomenclature provides a new name for each third power of ten, and fills in the other two powers with appropriate prefixes: TEN MILLION, ONE HUNDRED BILLION. Mahâvîra's system adopts this technique in a limited way with DASA-SAHASRA and DASA-LAKSA, but it had been fully exploited by Kâccâyana who, in his Pali Grammar of the 1st century B.C., used seventh powers of ten:

1 dasa	3 sahassa	5 sata sahassa
2 sata	4 dasa sahassa	6 dasa sata sahassa

7 koti	42 akkhobhini	77 ababa	112 pundarika
14 pakoti	49 bindu	84 atata	119 paduma
21 kotippakoti	56 abbuda	91 sogandhika	126 kathâna
28 nahuta	63 nirabbuda	98 uppala	133 mahâkathâna
35 ninnahuta	70 ahaha	105 kumuda	140 asankhyeya

All the above systems of numeration have been expressed in the familiar decimal scale; each new name represents a number ten times larger. However, the 1st century B.C. Latitavistara introduced number names based on a centesimal scale:

7 koti	23 bahula	39 gananâgati
9 ayuta	25 nâgabala	41 nirvadya
11 niyuta	27 titilambha	43 mudrâ-bala
13 kaṅkara	29 vyavasthâna-prajñapti	45 sarva-bala
15 vivara		47 visaṃjñâ-gati
17 ksobhya	31 hetuhila	49 sarvajñâ
19 vivâha	33 karahu	51 vibhutangamâ
21 utsaṅga	35 hetvindriya	53 tallaksana
	37 samâpta-lambha	

For more detailed information on the subject, readers are referred to the History of Hindu Mathematics: A Source Book, Parts I and II, by Bibhutibhusan Datta and Avadhesh Narayan Singh (Asia Publishing House, Bombay, London, and New York, Single Volume Edition, 1962).